DOCUMENT RESUME

ED 273 498 SE 047 208

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TITLE	Responding to the Crisis in Math and Science Teaching: Four Initiatives. Final Report.
INSTITUTION	Educational Testing Service, Princeton, N.J. Education Policy Research Institute.
SPONS AGENCY	Ford Foundation, New York, N.Y. Education and Research Div.
PUB DATE	Dec 85
NOTE	22p.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Educational Research; Higher Education; Mathematics Education; *Mathematics Teachers; *Program Descriptions; Science Education; Science Teachers; Secondary Education; *Student Characteristics; Surveys; *Teacher Education Programs; *Teacher Supply and Demand
IDENTIFIERS	Mathematics Education Research; Science Education Research

ABSTRACT

Four nontraditional teacher education programs to attract and train mathematics and science teachers are described. Three of the programs are aimed at midcareer professionals; the fourth is aimed at recent college graduates who did not prepare to become teachers as undergraduates. All are small programs; they provide models for other institutions to follow. The programs are at Harvard University, the University of Massachusetts, the University of Vermont, and Washington University in St. Louis, Missouri. The study was organized around six research questions: (1) What are the characteristics of these programs? (2) What are the characteristics of their students? (3) What attracted the students to the programs? (4) What are students' evaluations of the programs? (5) What are the career plans and motivations of the students? and (6) What are the recommendations of the students for program design? After the six questions are answered, conclusions and recommendations are presented and five suggestions for further research are given. (MNS)

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Responding to the Crisis in Math and Science Teaching:

Four Initiatives

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Final Report

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Educational Testing Service

December 1985

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Introduction

One of the most serious challenges to American education, and to our society, is the shortage of math and science teachers at the secondary level. All states now have or project a shortage in the supply of math and science teachers (McGeever, 1985). The demand for such teachers is increasing as states increase graduation requirements in those subjects, enrollments grow during the next decade, and our technologically advancing economy places greater demands for mathematical and scientific literacy on our citizens. The situation appears to be getting worse as small numbers of math and science graduates apply for teaching jobs and experienced teachers leave the schools for more lucrative jobs in industry and business.

Responses to this problem include job sharing by trained teachers who seek only part-time employment, more use of technology to replace teachers, lending arrangements between business and industry and the schools on a short-term basis, employment of foreign nationals, retraining of teachers from other disciplines, and the use of financial incentives to attract math and science majors to enter teaching (Levin, 1985). In addition, a number of programs have been designed to attract midcareer professionals to second careers in math and science teaching.

The purpose of this study is to describe four nontraditional math and science teacher education programs and the students they attract. Three of the programs are aimed at midcareer professionals; the fourth is aimed at recent college graduates who did not prepare to become teachers as undergraduates. All of the programs are small. Their role in increasing the quality and supply of math and science teachers may be viewed as providing models for other institutions to follow. By describing the features of these programs and the attractions that they hold for potential teachers, we hope to provide information to others who may wish to conduct similar programs.

Research Questions

The study is organized around six research questions:

1. What are the characteristics of these nontraditional programs?

2. What are the characteristics of their students?

3. What attracted the students to the programs?

4. What are the students' evaluations of their programs?

5. What are the career plans and motivations of these students?

6. What recommendations do these students make for the design of programs to attract students like themselves?

Procedures

The four programs included in this study were selected as illustrative of nontraditional approaches to attract and train secondary school math and science teachers. These programs were selected from a larger group of programs previously identified by the Ford Foundation. Programs whose primary purpose was to retrain teachers for math and science teaching were excluded.

Names and addresses of current students and recent graduates of the programs were obtained from the institutions. Staff at each institution also provided descriptions of their programs. A mail survey of the students was conducted in the Spring of 1985. The numbers for each program and the survey's response rate are given below.

Institution	Students/ Graduates	Responses	Response Rate*
Harvard	24	19	86%
U. of Massachusetts	41	32	80%
U. of Vermont	12	5	42%
Washington University	12	8	80%
Total	89	64	76%

*Response rate was computed by reducing the number of questionnaires mailed by the number that were undeliverable or were sent to individuals who reported that they were not involved in the program.

What Are the Characteristics of the Programs?

The programs included in this study are: (1) Harvard University's Midcareer Math and Science Program; (2) The University of Vermont's Teacher Preparation Program for Professional Engineers, Scientists, and Mathematicians; (3) Washington University's Post-A.B. Teacher Certification Program; and (4) The University of Massachusetts' Math/Science/Technology Education Project (M/S/TEP). Profiles of each of these programs are provided below. All four of these math and science initiatives were launched in the early 1980s, although Vermont's program is provided through its Post-A.B. program, which has existed since the 1960s. The programs have developed slowly and deliberately, admitting small numbers of students who show strong

potential for classroom careers. While the programs intend to grow somewhat, the hope is that they will serve as models for other institutions to follow.

Three of the programs--Harvard, Vermont, and Washington--focus on retraining midcareer or retiring professionals to become teachers. The M/S/TEP program is more traditional in that most of the students have recently graduated from college. In addition, private corporations play a role in both Washington's program and in M/S/TEP. We provide brief descriptions of each program below. Program staff who can be contacted for more information about the programs are listed in the Appendix.

Harvard Graduate School of Education Midcareer Math and Science Program

In 1983, Harvard initiated the Midcareer Math and Science Program (MCMS), a teacher training program to enable midcareer professionals in quantitative fields to become secondary school teachers. Now working with its third class, program sponsors and admissions personnel report over 600 annual inquiries from those wishing to change careers and numerous requests from other institutions of higher education wishing to implement the Harvard program.

The program enables midcareer professionals from high technology, scientific research and financial services who already possess quantitative backgrounds to become certified secondary school math and science teachers in Massachusetts and thirty other states. Recent graduates include a retired rear admiral; a meteorologist; chemical, civil, and aeronautical engineers; a microbiologist; a biochemist; and several technical researchers. All are currently teaching full- or part-time in the fields of math, physics, chemistry, biology, and general science.

The program employs a heavy field work component and encourages more direct communication and collaboration between current teachers--who are training the next generation of technicians--and professionals with direct knowledge and experience in the technological workplace. The importance and potential of this exchange is fundamental to the program design because it represents a unique approach to develop a dynamic relationship between schools and the scientific community.

New Teachers. The MCMS program began in September 1983, with an initial class of five. By the Fall of 1984, the program had expanded to 20, and to 21 in Fall 1985. The number of participants is limited because those in mid-career need specific support and assistance in making this transition. Although the number of participants seems small in the face of a teacher

shortage, the notion is that the program will serve as a model for other teacher education programs.

Selection. The selection process is rigorous and intends to identify candidates with a high probability of success in the classroom. In addition, applicants must demonstrate a sensitivity for working with other staff since their transition to a secondary school may be threatening to other staff members. The application process is detailed and requires a personal or telephone interview with the candidate and the admissions committee.

The Program. The nine month program, which leads to teacher certification, includes a total of eight courses divided between educational theory, methods of teaching math and science, classroom practica, and electives. Specific courses include: Teaching and Learning, Improving Schools, two methodology courses, and two electives taken from university at large. Students also do full-time student teaching for 12 weeks. Nearly all of the courses include a field study component which will bring MCMS students into schools and in contact with high school students and teachers throughout the year. Applicants who enter the program with adequate but not recent preparation in math and/or science may choose to use electives or summer study to refresh their substantive backgrounds.

Tuition for 1983-84 was $8,320 with significant financial support available from corporations and foundations. Utilizing field placements developed through the program, and the support of the School of Education Career Planning and Placement Office, candidates have direct access to the large number of job opportunities for qualified teachers. Nearly all of the graduates have had two or three job offers each.

Recruitment. Harvard's efforts to locate individuals interested in the program fall into four activities: 1) contacting personnel directors and/or retirement counselors in selected corporations with a high concentration of individuals with quantitative training; 2) contacting out-placement and job placement firms in the Boston area; 3) announcing the program through established professional organizations; and 4) placing articles in area newspapers, alumni bulletins and professional journals. In addition, articles about the program have appeared in numerous magazines and journals.

Math/Science/Technology Education Project, School of Education, University of Massachusetts at Amherst

The Math/Science/Technology Education Project (M/S/TEP) is a collaborative effort of a consortium of Massachusetts public schools, the Digital Equipment Corporation (DEC) and several other companies, and the University of Massachusetts School of

Education. Launched in early 1983 as a step toward alleviating the critical national shortage of excellent science and math teachers, M/S/TEP has been hailed as a model for attracting high quality young people into teaching, and for improving science and math education nationally. Its goals are to attract talented new people to secondary school teaching in the sciences and mathematics, and to provide a research and development site for the introduction of new technologies into teaching practice. The University of Massachusetts anticipates continuing and expanding this pilot program in future years.

The first goal, training new teachers, is achieved through a graduate degree program leading to a master's degree and certification to teach math and/or science. The partners in the program share in the design and implementation of the program, which includes internships in schools and industry. The second goal, introducing new technologies into teaching, is accomplished through ongoing involvement of the M/S/TEP students both in high school teaching and in the industrial sector, during their graduate program and in subsequent years. The program has graduated two classes, and is now training a third.

The program has received financial support from the Fund for the Improvement of Post-Secondary Education, the Bay State Skills Corporation and the Massachusetts Regents of Higher Education. The Digital Equipment Corporation provided major support in the form of internships for all students in the first two classes. They also have donated 25 personal computers to the University to be used in the project. Each student has a computer to use during the program and students are strongly encouraged to use their computers in their teaching. Several senior DEC staff members are serving as visiting faculty, teaching M/S/TEP courses and supervising student interns. Other companies providing internships include the Bank of Boston, New England Telephone, Spinnaker Software, Houghton-Mifflin Publishers, and Data General Corporation. The Massachusetts High Technology Council and the Boston Private Industry Council are represented on the M/S/TEP Planning Board, and facilitate industry participation.

A consortium of 50 public school systems in the greater Boston area comprises the school component of the M/S/TEP collaboration. The superintendents of five of the systems are members of the M/S/TEP Planning Board. As affiliates of the program, the school systems agree to consider hiring M/S/TEP students as teaching interns when a vacancy occurs in math or science. The salary of teaching interns is typically the prorated salary of a first-year teacher. In return, the responsibilities of interns are substantially equal to those of teachers. Each school system hiring an intern also names a Supervising Teacher to work with the intern, in collaboration with a university supervisor.

Program. The academic program of M/S/TEP consists of four phases: an intensive preparatory summer program followed by two semesters of internship and study, in turn followed by another summer program of study. The entire program takes 15 months to complete with a total of 51 credits. Students obtain certification to teach mathematics or one of the sciences at the secondary level and earn a master's degree (M.Ed).

During the first summer students work as "apprentices" in an intensive summer academic program for high school student. Each M/S/TEP students works under the tutelage of an outstanding experienced teacher (called Mentor), teaching under supervision, and spending several additional hours a day in a tutorial relationship with his or her Mentor. In addition, the students as a group meet daily with University faculty, experienced teachers, and visiting faculty for courses and seminars to prepare them for their teaching roles, and to provide the knowledge base required for certification.

For one semester of the academic year, students are teaching interns in a participating school. They have substantially the same responsibilities as a teacher, but they can count on the help and guidance of the Supervising Teacher nominated by the host school system. For the other semester, students are interns in a participating company. Their internship is educational in nature (for example, developing course material for use in the company's training programs), and they are supervised by a senior company staff member, as well as by University faculty. During the academic year, students also take part in courses and seminars organized by University faculty, in collaboration with professionals from industry or school systems who serve as adjunct faculty. During the second summer, students participate in further University course work which focuses on educational uses of new technologies such as computers and interactive videodisc systems. They also participate in the summer program for high school students, as guides and consultants to the new group of M/S/TEP students and as assistants to the Mentors.

Upon completion of the program, students make a commitment to remain in teaching for at least three years. After that, graduates may continue teaching, use their skills in a high technology industrial setting, continue graduate work, or combine these.

Students. After the applicants' credentials are reviewed by the M/S/TEP faculty, promising individuals are invited for interviews. Typically, these are all day group interviews and are held at DEC's Education Service headquarters. To be offered admission, candidates must be recommended by interviewers from schools, industry, and M/S/TEP faculty. The program is highly selective. In 1983-84, 100 applicants were interviewed and 19 were accepted.

The 41 students in the first two classes (1983-84 and 1984-85) of the program all hold bachelor's degrees in math or science, with about equal numbers in life sciences, physical sciences, and mathematics. The mean of their undergraduate GPA is 3.4 on a scale of A = 4, and their average GRE score is in the 80th percentile on the verbal test and in the 90th percentile on the quantitative test (compared to all students nationally and in all fields who take the GRE, required for admission to most graduate schools). The 24 women and 17 men include graduates of Harvard, MIT, Penn State, the University of Massachusetts, Smith, Tufts, Wellesley, the University of California (Berkeley), and Stanford. Four are members of minority groups.

Compensation and Tuition. Students in the industry internship receive about $7,500 for 20 weeks. During the school internship component, interns are paid the regular salary of a first-year teacher (the median salary for one semester is approximately $7,500. Thus, the median income of the M/S/TEP students from the teaching and industry internships is about $15,000.

In 1984-85, the total cost for tuition and fees for the 14 month program was $2,922. Students in the program are entitled to all financial aid available to graduate students in the University.

Teacher Preparation Program for Professional Engineers, Scientists, and Mathematicians, University of Vermont

This program, begun in 1983, is operated within the University of Vermont's Fifth Year Certificate in Education Program which was initiated in the early 1950's. The program is designed to provide the necessary courses and experiences deemed necessary for the preparation of teachers, both elementary and secondary, at the post-baccalaureate level. This program is used in an initiative to prepare retiring engineers, scientists, and mathematicians for secondary school teaching positions. The program accommodates the special nature of this population and provides support services for the students as they change careers.

Admission requirements include a satisfactory undergraduate major at the Bachelor's level, a commitment to working with young people supported by individual references, and a planned development program. The curriculum includes extensive study in the psychology of adolescent development and learning, the intellectual and social foundations of American public education, highly structured observation experiences in schools, combined general and special teaching methods courses, and a supervised teaching internship.

The one-year program requires 30 semester hours of study. The aim is to provide requisite courses in education (methodology, pedagogy), supervised student teaching (15 weeks) and a refresher course on subject area. The program begins with a seminar on the transition from business to teaching, followed by content courses, courses on the nature of the secondary school, and adolescent psychology. Upon completion of the required courses, participants engage in field experience and are encouraged to take as many electives as possible. Suggested are courses in computers, educational measurement, educational media, and reading. A final paper must be submitted under the direction of the faculty advisor.

Tuition is $2,680 for Vermont residents and $7,440 for non-residents. Participants pay their own tuition; however, cooperating industries provide stipends for some of the participants. The university provides assistance in finding teaching jobs for graduates.

As of December 1984, the program had 10 students and two graduates. Most of the students attend the program on a part-time basis.

Washington University Post-A.B. Teacher Certification Program

Washington University has provided the opportunity for those who desire teacher certification without completing requirements for an advanced degree since at least the 1960s. In addition, for many years, the university has offered a Master of Arts in Teaching Degree. Coursework for the Post-A.B. program may be completed on a part-time basis through University College (the evening division of the College of Arts and Sciences), which offers substantially lower tuition than the day school. The program is directed toward students with little or no coursework in education but a strong undergraduate preparation in the subject to be taught. Successful completion of the Post-A.B. program leads to certification in any of ten subject areas: art, classics, dance, English, mathematics, modern foreign languages, music, the sciences (biology, chemistry, earth science, physics), social studies, or speech/theatre. Washington University's NCATE accreditation validates this certification in a majority of states via reciprocity agreements.

In 1983, the University joined forces with the Monsanto Company in an attempt to ease the growing shortage of high school science and math teachers in the St. Louis area. Through the Post-A.B. program, retiring or near retirement engineers from Monsanto's Engineering Department can prepare for a new career in math or science teaching. The shortage of math and science teachers came at a time when Monsanto's needs for engineers on plant expansion and related capital projects was decreasing, and staff realignments were expected. In addition to those

considering early retirement, who generally are in their 50s and have been with Monsanto for more than 20 years, inquiries have been received from employees already retired and younger staff members, as part of their longer-term career plans. The developers of the program felt that the engineer's technical background and expertise, combined with the teacher education experience that they could receive through the program, would give them the tools to become effective science and math teachers.

The program offers several options for the engineers. They can attend night school or summer classes on either a full- or part-time basis over a period of one to three years. The program leads to either a post-bachelor's teaching certificate or an MA degree in teaching. Monsanto works on an individual basis with interested engineers on contracts, scheduling, and financial aid. In most instances, the employees are eligible for tuition assistance under Monsanto's program. The Post-A.B. program requires about 24 hours of education courses if all requirements within the teaching field (math or science) have been met. The courses are divided between pre-professional (social foundations) and professional (methods, reading in content areas). All students take education psychology for teachers, which has a clinical component, 5-6 hours in a classroom under supervision. Student teaching is also required. The other option, a master's in teaching, adds 12 hours of advanced coursework to the 24 hours.

What Are the Characteristics of the Students?

Because of the differences in the nature of the midcareer programs and the M/S/TEP program, as well as differences in the types of students these programs attract, relevant distinctions between these two groups of students are made throughout the following discussion. Over 90 percent of the students are white. For the midcareer programs, 69 percent are males; for M/S/TEP, 47 percent are males. All of the M/S/TEP students are under 30, with two-thirds between 22 and 24. For the retraining programs, 31 percent are under 30, 28 percent are between 32 and 49, 28 percent are between 51 and 58, and 12.5 percent are over 60. Eighty one percent of the M/S/TEP students come from a family where the major breadwinner was professional or semiprofessional, compared to only 41 percent of the midcareer students.

Nearly one-third of the midcareer students majored in engineering, 22 percent majored in biological science, and six percent each majored in math and physical science. For M/S/TEP, about a third majored in math, a third in physical science, a quarter in biological science, and a tenth in engineering. Both groups earned good grades. About 94 percent of all students had a GPA of B or better as undergraduates. Nearly two-thirds of the M/S/TEP students received academic honors as undergraduates and

more than a third of the midcareer students did so. About 30 percent of all the students took at least one education course as undergraduates. Although a few students had teaching experience prior to entering the program and two individuals had

certification, nearly all of these students enrolled with no prior teaching experience or training in education.

All of the M/S/TEP students entered the program with a bachelor's degree and two had earned a master's prior to entering the program. Many of the midcareer students had earned advanced degrees--23 percent held a master's degree, 6.5 percent held a professional degree, and 10 percent held the doctorate.

While the M/S/TEP students generally came right out of undergraduate school (a few taught for a year or two and several held professional positions outside of education), the midcareer students had considerable professional experience prior to entering the program. Table 1 shows this experience.

Table 1

Prior Professional Experience of Midcareer Students

Professional Field	# of Students	Mean Experience (Years)
Biological Science	8	6.5
Physical Science	1	34.0
Engineering	10	26.3
Computer Science	4	5.0
School Teaching	4	3.3
College Teaching	1	4.0
Other Education	1	10.0
Military	6	9.5
Business	1	6.0

Finally, more than three-quarters of all the students had education-related experiences prior to entering their program (tutoring students, staff training or development) that influenced their decision to enter their programs.

What Attracted the Students to the Programs?

The efficiency of the program in granting both an advanced degree and a teaching credential was a major attraction to a substantial proportion of the students. The relatively short time necessary to complete the programs was cited as an attraction by most respondents. The programs' accommodation to

the personal situation and schedule of the students was another program feature that was also often cited.

The availability and location of the program was also cited as an attraction by many of the students. Other attractions included the specific design of the programs for midcareer students, the prestige of the institution offering the program, and the financial assistance that was provided. Many of the M/S/TEP students cited the combination of school and high technology industrial experience as attractive features and many commented that the paid internships made the program economically viable.

What Are the Students' Evaluations of the Programs?

Respondents were asked to rate several components of their teacher preparation program on a scale of one to five. The ratings were highly favorable for all program components for both types of programs. For the M/S/TEP students, the highest rated component was the teaching internship--97 percent of the students rated this component as valuable. When asked to indicate the most valuable component of the program, 90 percent of the M/S/TEP students picked the teaching internship. M/S/TEP's industry internship was rated highly by 57 percent of the students and the coursework in education was rated highly by 42 percent.

The program component ratings for the midcareer students were also favorable. Ninety-one percent of the respondents gave high ratings to the student teaching experience and the student teaching seminar. Over three-quarters gave high ratings to the education coursework. Sixty-one percent selected student teaching as the most valuable component of the program and almost a fifth selected the education coursework.

While students appeared confident in their knowledge of their subject area and fundamental instructional skills, they were less certain of their ability to cope with the diversity of personalities and ability levels of students. Management of behavior problems and dealing with less academically able students were mentioned as areas requiring further preparation. In addition, concerns were expressed by midcareer people regarding their difficulty adjusting to their new professional roles. Some respondents mentioned lack of acceptance by school personnel, particularly administrators, and difficulties in adjusting to loss of status and responsibility.

What Are the Students' Career Plans and Motivations?

This section describes the students' reasons for wanting to become a teacher, their career plans immediately following completion of the programs, and their longer term career plans.

Reasons to Pursue a Teaching Career. The responses to this open-ended question revealed a variety of reasons to teach. Many of them were altruistic, many had to do with combining an interest in children and science, and many of the reasons were pragmatic. These potential teachers were very aware of the national crisis in education and felt that they were in a position to do something about it. The opportunity to use their expertise in a personally rewarding way was cited by several of the respondents and many expressed a desire to work with, and help, young people. Many of the midcareer students stated that teaching was something they always wanted to pursue. The interaction with other people, often lacking in research and technical positions, was also seen as a benefit of teaching.

Some of the benefits of teaching jobs correspond well to the personal situations of these students. The hours and vacations available to teachers were cited by many respondents as enabling them to semi-retire yet remain mentally active. The lower income that teaching provides is less of an impediment to these individuals now that their children have finished college and their financial needs have diminished. In addition, the availability of pensions may help cushion the decrease in earnings.

Career Plans. Respondents were asked to indicate what they planned to do (or were doing) immediately following completion of their programs and to speculate on their current career plans related to secondary teaching. Of the 12 M/S/TEP students who had completed the program before August 1985, eight were teaching math and science at the secondary level and four were employed in other jobs. Of the eight midcareer students who had already finished their programs, four were teaching, three were looking for a teaching position, and one individual planned to stay with his current career.

The students who had not completed their programs until August, 1985 or later were asked to indicate their immediate plans regarding teaching. For both the midcareer and M/S/TEP students, about 85 percent indicated that they planned to teach at the secondary level. A few reported that they planned to pursue a position outside of education, a few had no immediate career plans, and one individual intended to pursue a non-teaching position within education.

All respondents were asked to characterize their thinking about their career in secondary teaching. As might be expected there were differences between the midcareer students and the younger M/S/TEP students. About 70 percent of the midcareer students planned to make secondary teaching their career, as opposed to only one-quarter of the M/S/TEP students. The remainder of the midcareer students planned to teach for awhile and then pursue another career, either inside or outside of education. Twenty-eight percent of the M/S/TEP students planned

to teach for a while and eventually pursue another career, more than one-third indicated that they did not know what they were going to do, and a few individuals planned to teach until they could move into an administrative position in education.

What Are the Students' Program Recommendations?

All respondents were asked to recommend ways to attract and train secondary school math and science teachers. Students in the midcareer programs were also asked for their program design recommendations in terms of coursework, classroom teaching and/or observation, and administrative services (scheduling, counseling, placement assistance, etc.).

Suggestions of ways to attract talented individuals to math and science teaching careers can be summarized in four areas--enhance the professional status of teachers, improve working conditions within the schools, actively recruit able students, and improve the training of teachers. Many respondents felt that a major problem in attracting teachers is the perceived status of education and of teachers. Increasing the autonomy and independence of teachers and recognizing the skill, knowledge, and talent that is required in teaching were suggestions made by several respondents. Related to this, the working conditions within the schools was frequently mentioned as needing improvement if teaching is to be an attractive career alternative. Specifically, suggestions had to do with paying teachers more, providing them with career paths, rewarding better teachers with better pay, improving discipline and security within schools, and providing better curricula and materials.

Respondents also offered specific recruitment recommendations. These included making the programs known to military retirement offices, engineering and other professional societies through their publications and trade journals, and actively recruiting students in undergraduate school. These efforts should emphasize the personal fulfillment offered by teaching and the contribution that can be made to American youth and to the future of society.

Regarding the training of teachers, respondents suggested that that early classroom experiences be provided to potential teachers and that financial assistance be more readily available especially in the form of forgivable loans. Other suggestions included developing more cooperative programs with business and industry and persuading school administrators that retiring or midcareer professionals are a viable source of teachers.

Specific recommendations were also made for teacher education coursework, classroom teaching/observation, and administrative services. Many recommendations concerned the need to emphasize how to teach the subject, since most of this pool of students are

accomplished in their fields. The teaching of methodology was seen as important to these students. Suggestions included peer teaching, micro-teaching, and the modeling of teaching methods. In addition, it was suggested that more attention be paid to showing how to teach the slow learner and that the programs provide more practical knowledge about presenting material and dealing with student conduct and understanding adolescents. The comment of one student summarizes the feeling of a number of respondents. The teacher education program should provide for "the review of the spectrum of suggestions on how to motivate, satisfy, and live with teenagers."

Recommendations for classroom teaching/observation included allowing the student to observe and intern with a master teacher and observing the teaching of a range of courses offered in a subject area, from remedial to advanced. Administrative suggestions included more financial assistance, offering courses in the evenings, better career placement services, and the provision of counseling and coaching from time to time during the teacher's first year on the job. Finally, it was suggested that that prejudice against the unorthodox teacher candidate needs to be reduced.

Summary

This study examined four programs that are preparing highly competent individuals for math and science teaching positions in secondary schools. While they all seek to attract students who might otherwise not have entered teaching, the type of students they attract and the nature of the preparation differ. Three of the programs (Harvard, Vermont, and Washington) seek to recruit midcareer or retiring professionals who have considerable professional experience. Programs requirements are tailored to address the diverse backgrounds and needs of these nontraditional students, while also satisfying state certification requirements. The emphasis is on education coursework since students already possess knowledge of, and experience in, applying their academic disciplines. Academic refresher courses are offered if needed. Flexibility is available for both course selection and scheduling, permitting students to maintain their current positions while taking courses either part-time and/or in the evening.

The M/S/TEP program at the University of Massachusetts is more similar to the MAT model of teacher education. This program recruits younger college graduates with strong academic preparation in math and science. The program is offered on a full-time basis and has a prescribed sequence of coursework and other experiences for all students. Unlike the other three programs, students in this program serve paid internships, both in schools and in industry.

The survey results are summarized below.

o Eighty-five percent of the students are planning to enter teaching following completion of their programs.

o While many students noted that obtaining an advanced degree and teaching credential was a primary program attraction, the design of the programs appeared to influence students' decisions to enroll. For M/S/TEP students, the combination of school and industry internships affording both diverse experience and financial support was very attractive. For midcareer or retiring professionals, the accommodation of course requirements and scheduling to personal circumstances was an important consideration.

o There was agreement that actual classroom teaching was the most valuable experience provided by the programs, and despite the diversity of program offerings, most students indicated general satisfaction with their preparation to teach.

o While actual teaching is considered the most valuable training experience, instruction in educational methods was also recognized as important. Student recommended that teaching experience begin early in their program and recommended opportunities for evaluative feedback such as micro-teaching.

o While both groups of students appeared confident about their ability to teach their subjects, they expressed concern about their ability to deal with individual student differences and behavior problems. Midcareer students also expressed difficulty with adjustment to a new professional role.

o Reasons for entering teaching given by these students are similar to the reasons given by other teachers. These students are aware of the problems in education and see teaching young people as an opportunity to contribute to the betterment of society. They bring not only a knowledge of their subject matter to their teaching, but also a desire to motivate and stimulate their students' interest in their subjects.

o Not surprisingly, a large proportion of midcareer students indicate that they plan to make teaching their career, while the M/S/TEP students are less certain of the long term career plans.

o Several respondents made comments about potential problems of acceptance of the nontraditional teachers by school personnel.

Conclusions and Recommendations

Since this study was exploratory in nature and involved a small number of programs and students, generalizations about the findings must be qualified. But despite these limitations, the findings are relevant to the issue of improving the pool of math and science teachers. The students attracted to these programs were highly qualified and experienced in math and/or science. While the younger students may not make teaching their careers, a substantial number of them report that they plan to teach and thus will enrich the teaching pool for some period of time. Since the older students' personal and professional circumstances are quite different, they may in fact teach for the rest of their careers. Reduced financial burdens and the desire to pursue more person-oriented positions may serve to keep them in teaching. This latter group represents a new and relatively untapped source of teachers.

Respondents made some good suggestions for recruiting midcareer or retiring professionals that such programs might consider incorporating into their practices. These recommendations included contacting military retirement offices, advertising in professional journals, and addressing professional meetings. For both groups of students, financial support was seen as an important recruitment incentive.

Classroom experience should be provided early in students' programs. From the students' perspectives, opportunities for classroom observation and practice teaching are essential. Such opportunities can help students to understand the realities and demands of classroom teaching and increase their awareness of the types of skills they need to become effective teachers. Exposure to "master teachers", teaching a subject to different levels of students, would be an effective practice. Finally, these students need to be specifically trained to deal with individual student differences and behavior problems.

Cooperative planning between industry, school districts, and the university appears essential for a number of reasons. For M/S/TEP students, exposure to both schools and industry during their internships served both as an attraction to the program and as an opportunity to evaluate their career options. Paid internships were mentioned by many as an important attraction to the program. For midcareer students, cooperative arrangements afforded release time and/or financial support. A number of these students indicated that these arrangements could be improved to promote greater support from their employers.

The midcareer students are making a critical transition in their professional lives. While many held management or technical positions with considerable responsibility and professional respect, they are now entering a new field where they are perceived quite differently by school personnel. They

now find themselves as novice teachers, despite their wealth of knowledge and experience outside of education. Transition supports in the form of seminars and individual counseling are being offered and appear helpful. There does, however, seem to be a need to deal more directly with school personnel in student teaching placements and to discuss with students themselves strategies to facilitate their acceptance. Greater involvement in planning and supervision by administrators, as well as cooperating teachers might help to alleviate this concern.

Need for Further Research

From this study we were able to obtain an overview of four nontraditional math and science teacher education programs and establish an initial data base of their students' characteristics, motivations, and assessments of their programs. In order to understand the conditions likely to engender successful programs as well as to discover personal and situational factors that influence graduates' attraction to such programs and their subsequent adjustment to teaching positions, we recommend that:

1. The data base provided by this study be expanded by identifying additional nontraditional programs preparing math and science teachers. This group can be followed-up periodically to assess their teaching experiences.

2. Existing knowledge of these types of programs be augmented by conducting surveys, in-depth interviews, and perhaps on-site interviews with students and program personnel in similar programs.

3. Case studies and other analyses be prepared that identify program elements that are important to the attraction, training, and adjustment to teaching of these nontraditional teacher education students.

4. The results of this research be systematically disseminated to teacher educators and other policymakers who are concerned with the quality and quantity of secondary math and science teachers. The dissemination strategy should identify and include the range of industry-school partnerships that exist.

5. The degree of interest in teaching as a second career among midcareer professionals with backgrounds and training in math and science be assessed.

References

Levin, Henry M. Solving the Shortage of Mathematics and Science Teachers. Stanford University, Institute for Research on Educational Finance and Governance, Program Report No. 85-A2, January, 1985.

McGeever, James M. Retraining Programs to Alleviate Teacher Shortages in Mathematics and Science. Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, Illinois, April, 1985.

APPENDIX

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